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The Use of Medicinal Plants by Hemodialysis Patients in Northern Morocco

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Abstract **Introduction:** The global prevalence of End-Stage Renal Disease (ESRD) requiring hemodialysis is rapidly increasing. In Morocco, many patients turn to Medicinal Plants (MP), driven by socioeconomic and cultural factors. However, unsupervised MP use poses a risk of acute renal failure. **Objectives:** This study's objective was to assess the prevalence of MP use among hemodialysis patients in northern Morocco, identify the species used and analyze correlations between the type of medicine preferred and the participants' socioeconomic characteristics. **Methodes:** A cross-sectional study surveyed 329 ESRD patients at public centers (Sept 2024-Apr 2025) using a questionnaire for sociodemographic and ethnobotanical assessments. Only medicinal plant users (248) completed it. Data was analyzed using SPSS (v. 27.0), employing Spearman's correlation. **Results:** The population was mainly female (51.6%), illiterate (66.5%) and had no income (79.4%). MP consumption is very high, with 76.8% using them for their ESRD, particularly those aged 60 and over. Fifty-three MP species were identified (e.g., Lamiaceae, Apiaceae), including *Allium sativum* and *Moringa oleifera*, mostly used in decoction. The type of medicine used, traditional or combined, was significantly associated with age ($r = -0.245$, $p<0.001$), educational levels ($r = 0.141$, $p = 0.026$), monthly income ($r = 0.210$, $p = 0.001$) and social security coverage ($r = 0.167$, $p = 0.008$). **Conclusion:** Medicinal plant use is frequent among older, low-income hemodialysis patients in northern Morocco. However, the misuse of these plants poses significant health risks, including potential kidney damage and adverse interactions with prescribed medications. This underscores the urgent need for targeted awareness campaigns to educate patients about the safe use of medicinal plants and to mitigate these risks.

Key Words Hemodialysis Patients, Morocco, North Africa, Medicinal Plants

INTRODUCTION

The end-stage renal disease (ESRD) is currently considered as the 12th cause of mortality and the 17th cause of morbidity [1] and has been declared a key public health priority in several countries [2].

In Morocco, hemodialysis for ESRD rose from 162 to 197.8 pmh between 2004 and 2008, reaching 905 pmh in 2017. Annually, over 5,000 Moroccans enter the terminal stage of CKD, with ESRD incidence between 100 and 150 new cases per 106 inhabitants [3].

Despite advancements in chronic disease treatment, Traditional Medicine (TM), especially Medicinal Plants (MP), remains prevalent, particularly in developing countries [4]. In Morocco, the majority of the population uses MP for various health issues, including kidney diseases [5].

MP may play a role in the management of various chronic diseases, including end-stage renal disease; they may possess antioxidant, anti-inflammatory and kidney-protective properties. However, without proper medical supervision, the use of these plants may pose significant risks to patients with ESRD, such as nephrotoxicity and the possible presence of harmful contaminants [6].

Ethnobotanical studies conducted in Morocco and other parts of North Africa have found that organic plants are of significant value in the management of kidney disease. For example, in southeastern Morocco, specifically in the Errachidia region, 49 medicinal plants are used to treat kidney diseases, including urinary stones [7]. A different study conducted in the western Rif of Morocco found also that local communities relied on various available plant

species to treat pain, inflammation and other kidney ailments [8]. These works underscore the persistence and richness of local traditional knowledge for the management of kidney disease.

However, several previous studies have identified toxic MP used locally and associated with risks for renal function, particularly in patients with renal failure. Among these plants, *Peganum harmala*, *Nigella sativa*, *Lawsonia inermis* and *Atractylis gummifera* are known for their proven nephrotoxicity [9]. Moreover, the use of MP may cause interactions with other medications and can alter the efficacy and toxicity of standard treatments [10].

Unregulated use of MP poses a renal toxicity risk factor, which can aggravate renal function and induce renal failure [11]. In addition, self-medication with MP can produce renal impairment and lead to other serious pathologies [12].

This reliance on traditional remedies may arise from limited access to conventional medicine or cultural beliefs [13]. MP use varies based on patients' socioeconomic and cultural factors, including age, gender, education and environment [14]. Many hemodialysis patients frequently turn to herbal remedies, perceiving them as a means to enhance their physical, psychological and financial well-being [15].

Considering that Moroccan people, particularly in the northern regions, are significant consumers of MP [16], our objective was to create a comprehensive list of the specific medicinal plants used by ESRD population in northern Morocco, along with the reasons and methods for their use. We have calculated key ethnobotanical indices namely the Use Value (UV) and the Family Use Value (FUV) in order to quantitatively assess the importance and diversity of MP uses in hemodialysis patients. This could highlight potentially risky practices associated with these plants.

Additionally, we aimed to analyze the correlations between the socioeconomic characteristics of the participants and their preferences for traditional medicine use, in order to gain a better understanding of the socio-cultural and economic factors that influence these preferences.

METHODS

Data Collection

A cross-sectional study was conducted from September 2024 to July 2025 to gather data from ESRD patients at public hemodialysis centers in northern Morocco. We used an information sheet for sociodemographic data and the Arabic version of Benkhnigue [17], "Questionnaire on Medicinal Plants and Phototherapy" to collect details on medicinal plants used, including their common names, uses, treated conditions, plant parts and preparation methods. This questionnaire was subjected to a specific validation process for the new population studied. Moreover, it explored traditional medicine use by hemodialysis patients before and during ESRD, including duration and preferred medicine types (traditional, modern or both). The questionnaire was not given to patients who did not use traditional medicine. Although the questionnaire was mainly self-administered, for illiterate individuals, the interviewer carried out the administration by asking questions and completing the forms on their behalf.

It should be noted that the taxonomic identification of plant species was carried out from the literature and the catalog of Moroccan plants by Bellakhdar [18] which constitutes a reliable taxonomic basis for the identification of species in Moroccan ethnobotanical studies.

Inclusion Criteria

ESRD patients at public hemodialysis centers who consented to participate.

Exclusion Criteria

Patients with physical or mental limitations that may impair their ability to communicate or understand.

Sampling

Sample size was based on official data from the Ministry of Health in Tangier, Morocco. Eighteen public hemodialysis centers serve 923 ESRD patients across eight provinces. A stratified random sample of 379 patients was recruited.

It is important to emphasize that the hemodialysis centers of Imzouren and Targuiste were excluded from the study due to geographical accessibility issues, hindering the accurate collection of data in these sectors. Similarly, we apply the formula for calculating the sample:

$$no = (z)2\ p\ (1 - p\ )/d\ 2 \quad no = 272$$

where, d = Margin of error = 5%, Z = Confidence rate, p = 95% Heterogeneity: 50%).

For the calculation of the size (n) for a population of limited size, we will use the corrected Cochran formula:

$$n = 211$$

The final size is calculated taking into account an expected rate of non-response equal to 20%.

$$N = n+(n\ 0.2) = 253 \text{ patients}$$

$$\text{Cluster effect: } 253\times1.5$$

Minimum required sample size = 379 of patients with ESRD in public hemodialysis centers of TTA region.

- Patients who reported not using MP were excluded from the study

Data Processing and Statistical Analysis

To identify plant groups used by hemodialysis patients, Use Value (UV) and Family use value (FUV) [19] were calculated.

Use value (UV): UV estimates uses of a plant taxon and is calculated as follow:

$$UV = \Sigma Ui/n$$

Where, Ui represents the total number of uses reported for each plant taxon and n represents the total number of plant taxa collected in the survey.

Family Use Value (FUV): FUV assesses the importance of plant families and is calculated as follows:

$$FUV = UVs/Ns$$

Where, UV is the number of informants mentioning the family and Ns is the total number of species within each family.

Data were analyzed using SPSS version 27. Quantitative variables are presented as frequency and percentage. After normality testing, the Spearman correlation test assessed relationships between medicinal plant use and sociodemographic data, with $p<0.05$ considered significant.

RESULTS

Sociodemographic Characteristics of Participants

Among the 323 recruited patients, 248 (76.8%) use herbal medicines for ESRD management (Table 1). The gender distribution showed a slight female predominance (51.6% women, 48.4% men). Herbal use was common among hemodialysis patients, especially those aged 60+ (46.3%), with 29% aged 51-60, 11.2% aged 41-50, 8.8% aged 31-40 and 4.4% aged 18-30. Married patients used herbal medicines more (69.4%) than singles (19%), widowers (10.1%) and divorcees (1.6%). Geographically, 54.4% lived in rural areas and 66.5% are illiterate. Most hemodialysis patients (79.4%) had no income, while 16.1% had low income, 4% average income and 0.4% high income.

The Use of Medicinal Plants

Our results indicate that 53 plant species from 26 families are used by hemodialysis patients in the northen region of Morocco, with Lamiaceae (10 species), Apiaceae (7) and Asteraceae (6) being the most common (Table 2). To highlight the significance of MP for ESRD patients in public hemodialysis centers, we calculated their Use Value (UV). The most utilized species based on UV are *Allium sativum* (0.092), *Acacia senegal* (0.080), *Artemisia absinthium* (0.064) and *Moringa oleifera*, *Olea europaea*, *Nigella sativa* and *Verbena officinalis* (0.048 each). Other notable uses include *Lavandula angustifolia* (0.040) and *Allium cepa* (0.036).

The 53 medicinal species used by hemodialysis patients in the TTA region belong to 26 botanical families, mainly Lamiaceae (10 species), followed by Apiaceae (7 species) and Asteraceae (6 species). It should be noted that although Amaryllidaceae has a small number of species, it has the highest FUV (0.064).

Cultivated species make up 59.3% of the total, followed by wild species at 29.8% and imported species (Acacia senegal and Moringa oleifera) at 10.9%. Most patients (96.4%) use plants for therapeutic purposes, primarily to manage ESRD and related symptoms, while cosmetic use is minimal (1.2%). Other unspecified uses account for 2.4%.

Table 1: Sociodemographic Characteristics of MP users (n = 248)

Variable	Category	Frequency	Percentage
Sex	Man	120	48.4 %
	Women	128	51.6 %
Age	Between 18 and 30	11	4.4 %
	Years old	-	-
	Between 31 et 40 years	22	8.8 %
	Old	-	-
	Between 41 et 50 years	28	11.2 %
	Old	-	-
	Between 51 et 60 years old	72	29.0 %
	> 60 years	115	46.3 %
Family situation	Single	47	19 %
	Married	172	69.4 %
	Widower	25	10.1 %
	Divorced	4	1.6 %
Location	Douar	12	4.8 %
	Village	123	49.6 %
	City	113	45.6 %
Academic level	None	165	66.5 %
	Primary	54	21.8 %
	Secondary	14	5.6 %
	University	15	6.0 %
Monthly income (in dirhams)	Low	40	16.1%
	Average	10	4.0 %
	High	1	0.4 %
	No income	197	79.4 %
Social coverage	None	29	11.7 %
	AMO	168	67.7 %
	CNSS	46	18.5 %
	CNOPS	5	2.0 %

*No income: 0 dh/month (only social and family assistance), Low income: <3000 dh/month, Average income: 3000-8000 dh/month, High income: >8000 dh/month

Table 2: Information on Medicinal Plants used by Hemodialysis Patients in Northern Morocco

Family and scientific name	Vernacular name	Status	Use	Condition	Part used	Method of preparation	UV	FUV
Aloeaceae								
Aloe barbadensis Miller	Alouivera	Cultivated	Therapeutic	Fresh	leaf	Poultice	0.004	0.004
Amaranthaceae								
Beta vulgaris L.	Al'barba	Cultivated	Therapeutic	Fresh	Fruit	Raw	0.012	0.012
Amaryllidaceae								
Allium sativum L.	Thouma	Cultivated	Therapeutic	Fresh	Fruit	Raw	0.092	0.064
Allium cepa	Al'Basla	Cultivated	Therapeutic	Fresh	Fruit	Raw	0.036	
Anacardiaceae								
Pistacia lentiscus L.	Drou	Spontaneous	Therapeutic	Fresh and dried	Whole plant	infusion	0.004	0.004
Apiaceae								
Petroselinum crispum	Maâdnous	Cultivated	Therapeutic	Fresh	Whole plant	Decoction	0.008	0.007
Carum carvi L.	Al'Karouia	Cultivated	Therapeutic	Dried	Seed	Infusion	0.004	
Ferula gummosa	Fassoukh	Spontaneous	Therapeutic	Dried	bark	Fumigation	0.004	
Ammodaucus leucotrichus	Al'Kamoun Soufi	Cultivated	Therapeutic	Dried	Seeds	Infusion	0.008	
Pimpinella anisum L.	Habbat halâwa	Cultivated	Therapeutic	Dried	Seeds	Infusion	0.020	
Foeniculum vulgare	Nafaâ	Cultivated	Therapeutic	Dried	Seeds	Infusion	0.004	
Carum carvi L.	Karwiyâ	Cultivated	Therapeutic	Dried	Seeds	Infusion	0.004	
Astracées								
Inula viscosa	Tirhil	Spontaneous	Therapeutic	Fresh and dried	Leaf	Poultice	0.004	0.022
Artemisia absinthium L.	Chiba	Cultivated	Therapeutic	Fresh	Leaf	Decoction	0.064	
Artemisia herba alba	Chih	Spontaneous	Therapeutic	Dried	Leaf	Infusion	0.016	
Matricaria recutita	Al'Babounj	Cultivated	Therapeutic	Dried	Flower	Decoction	0.024	
Cynara cardunculus L.	Alkharshouf albariyu	Spontaneous	Therapeutic	Fresh	Fruit	Raw	0.004	
Cynara scolymus L.	Kherchouf	Cultivated	Therapeutic	Fresh	Stem	Raw	0.008	
Brassicacées								
Lepidium sativum L.	Hab rchad	Cultivated	Therapeutic	Dried	Seeds	Infusion	0.008	0.008
Burséracées								
Boswellia Carterii	Louban A'Dakar	Imported	Therapeutic	Dried	Bark	Maceration	0.008	0.008
Capparaceae								
Capparis spinose	el kebbar	Cultivated	Therapeutic	Dried	Fruit	Maceration	0.004	0.004
Caryophyllaceae								
Herniaria hirsuta L.	Herast Lhjar	Cultivate	Therapeutic	Dried	Whole plant	Infusion	0.016	0.016
Chénopodiacées								
Anserine vermifuge (*Chenopodium ambrosioides* L.)	M'khinza	Cultivated	Therapeutic	Fresh and dried	Leaf	Infusion	0.020	0.020
Cucurbitaceae								
Citrullus colocynthis	Lhdej	Spontaneous	Therapeutic	Dried	Fruit	Infusion	0.008	0.006
Cucurbita Pepo	Zriaât Leqraâ	Cultivated	Therapeutic	Dried	Seeds	Maceration	0.004	
Fabaceae								
Acacia senegal (Gum arabic tree)	A'Simgh Al'Arabi	Imported	Therapeutic	Dried	Bark	Maceration	0.080	0.034
Trigonella foenum-graecum L.	L'Helba	Cultivated	Therapeutic	Dried	Seeds	Infusion	0.012	
Lens culinaris	L'Aâdes	Cultivated	Therapeutic	Dried	Seeds	Raw	0.012	
Lamiaceae								
Rosmarinus officinalis	Azir	Cultivated	Therapeutic	Fresh and dried	Leaf	Infusion	0.032	0.016
Lavandula angustifolia	Lokhzama	Spontaneous	Therapeutic	Fresh and dried	Whole plant	Infusion	0.040	
Salvia officinalis L.	A'Salmia	Cultivated	Therapeutic	Fresh and dried	Whole plant	Decoction	0.004	
Origanum compactum Bentham	Zaâtar	Spontaneous	Therapeutic	Fresh and dried	Whole plant	Infusion	0.028	
Mentha spicata L.	A'Naana	Cultivated	Therapeutic	Fresh	Leaf	Decoction	0.028	
Calamintha officinalis	Mintha	Spontaneous	Therapeutic	dried	Leaf	Infusion	0.012	
Mentha pulegium L.	Fliou	Spontaneous	Other	Fresh and dried	Whole plant	Infusion	0.008	
Origanum majorana L.	Merdedouche	Cultivated	Therapeutic	Fresh and dried	Whole plant	Decoction	0.004	
Melissa officinalis L.	Mersita	Spontaneous	Therapeutic	Fresh and dried	Leaf	Infusion	0.008	
Marrubium vulgare L.	Mriwt	Cultivated	Therapeutic	After pretreatment	Flower	Decoction	0.004	
Lauracées								
Laurus nobilis	Waraq Al'Rand	Spontaneous	Therapeutic	Dried	Leaf	Infusion	0.008	0.008
Oleum Laurus nobilis	Zit Waraq Al'Rand	Spontaneous	Therapeutic	After pretreatment	Leaf	Raw	0.008	
Linaceae								
Linum usitatissimum	Zriaât Al'Kataan	Cultivated	Therapeutic	Dried	Seeds	Raw	0.012	0.012
Moracées								
Ficus carica L.	karmous	Cultivated	Therapeutic	Dried	Fruit	Raw	0.004	0.004
Moringaceae								
Moringa oleifera	Moringa	Imported	Therapeutic	Dried	Leaf	Raw	0.048	0,048
Myrtaceae								
Syzygium aromaticum	Al'Qronfel	Cultivated	Therapeutic	Dried	Flower	Infusion	0.008	0.006
Eucalyptus globulus	Kalitûs	Spontaneous	Therapeutic	Dried	Leaf	Inhalation	0.004	

Table 2: Continue

Oléacées								
Olea europaea	Waraq Al'Zaytoun	Cultivated	Therapeutic	Fresh and dried	Leaf	Infusion	0.048	0.048
Pedaliaceae								
Sesamum indicum L.	Zenjlan	Cultivated	Therapeutic	Dried	Seeds	Raw	0.012	0.012
Renonculacées								
Nigella sativa	Al'haba Asaoudae	Cultivated	Therapeutic	Dried	Seeds	Raw	0.048	0.048
Rutacées								
Citrus x limon L.	A'Laymoun	Cultivated	Therapeutic	Fresh	Fruit	Raw	0.024	0.024
Theaceae								
Mentha spicata L.	Atay	Cultivated	Other	Dried	Leaf	Decoction	0.016	0.016
Verbénacées V								
Verbena officinalis L.	Louiza	Cultivated	Other	Fresh and dried	Leaf	Infusion	0.048	0.048
Zingiberaceae								
Zingiber officinale	Al'Zanjabil	Cultivated	Therapeutic	Fresh and dried	Rhizome	Raw	0.020	0.014
Curcuma longa	Kharkoum	Cultivated	Therapeutic	Dried	Rhizome	Raw	0.008	

UV: The plant's usage value, FUV: Family Usage Value

Table 3: Correlation Between Sociodemographic and Type of Medicine Preferred

Parameters	Academic Level	Monthly Income	Social Coverage	Type of Medicine	Age	Location	Age
r	-	1	-0.134*	- 0.317**	-0.323**	-0.095	-0.245**
P	-	0.035	<0.001	<0.001	0.135	<0.001	-
R	-	-0.134*	1	0.310**	0.179**	0.145*	0.059
Location	P	0.035	<0.001	0.005	0.022	0.358	-
Academic level	R	-0.317**	-0.310**	1	0.401**	0.194**	0.141*
	P	<0.001	<0.001	<0.001	0.002	0.026	
Monthly income	R	- 0.323**	0.179**	0.401**	1	0.344**	0.210**
	P	<0.001	0.005	<0.001	<0.001	<0.001	
Social coverage	R	-0.095	0.145*	0.194**0.344**	1	0.167**	-
	P	0.135	0.022	0.002	<0.001	0.008	
Type of medicine	r	-0.245**	0.141*	0.210**	0.167**	1	-
	p	<0.001					
-	0.026	<0.001	0.008	-	-	-	-

**The correlation is significant at the 0.01 level (two-tailed), *The correlation is significant at the 0.05 level (two-tailed), #Type of medicine: Traditional medicine, Modern medicine or a combination of both types of medicine

Dried plants are predominantly used (45.2%), followed by fresh (33.1%) and both types (19.8%). After pre-treatment, marginal use is at 2%. Patients utilize various plant parts for preparations, with leaves being the most common (32.3%), followed by seeds (17.7%), fruit (17.3%), whole plants (14.5%), flowers (8.9%), bark (5.6%), rhizomes (2.8%) and stems (0.8%) (Table 3). The primary preparation method is decoction (41.1%), followed by raw (27.8%), infusion (21.8%), maceration (7.7%), poultice (0.8%) and fumigation/inhalation (0.4%).

Correlation Between Sociodemographic and Type of Medicine Preferred

The correlation analysis highlights several significant associations between sociodemographic variables and the type of medicine (traditional medicine, modern medicine or a combination of both) in Table 3. Age shows a weak to moderate negative correlation with preference for traditional medicine ($r = -0.245$, $p<0.001$). Academic level shows a significant correlation with the adoption of combined medicine ($r = 0.141$, $p = 0.026$). Finally, significant relationships emerge between income and combined medicine ($r = 0.210$, $p = 0.001$) and between social security coverage and combined medicine ($r = 0.167$, $p = 0.008$).

It is important to note that some relationships (e.g., age and social security coverage) are not significant, which highlights the specificity of the factors influencing patient choice.

DISCUSSION

This study found that 76.8% of ESRD patients in northern Morocco use MP, with a slight female predominance (51.6%). This may be due to women's vigilance regarding disease management, their use of plants and their traditional roles in family healthcare. Other ethnobotanical studies in Morocco [18] also indicate higher MP usage among women.

Our results show that older individuals in the studied region use MP more than younger age groups. Similar findings in Togo indicate that ethno-medicinal knowledge is primarily held by older adults [19] and in other Moroccan regions where ancestral MP knowledge remains strong among the elderly [20].

Over half of respondents (54%) are from rural areas, attributed to abundant vegetation. In fact, rural populations often have rich traditional knowledge of MP, essential for daily life and effective for health issues [21].

Most participants had no income, relying on family and social aid. In this term, most hemodialysis patients in Morocco are low- or zero-income, limiting access to modern healthcare and increasing reliance on traditional PM [22]. MP is cost-effective for common ailments [23].

The study shows that 66.5% of respondents are illiterate, aligning with [24] who noted that less educated populations heavily use medicinal plants for economic reasons and limited access to conventional care, which shows the need to educate this illiterate population.

The study identified 53 plant species from 26 groups used by hemodialysis patients, with 96.4% for therapeutic purposes. The most utilized species based on UV include *Allium sativum* (Thouma), *Acacia senegal* (A'Simgh Al'Arabi), *Artemisia absinthium* (Chiba) and *Moringa oleifera* (Moringa) [25]. Note garlic's benefits for lipid profiles in hypertensive patients, while [26] highlight Acacia's anti-inflammatory and antioxidant effects. Artemisia is valued for its anti-inflammatory, diuretic and digestive properties [27], provided that its use should be avoided or strictly controlled in hemodialysis patients due to potential toxicity risks. The patients in our study also used Moringa which aids diabetes management, with [28] reporting improved oxidative stress markers post-supplementation. These 53 plants species are belonging to 26 botanical groups; The Lamiaceae (10 species), Apiaceae (7 species), Asteraceae (6 species) and Fabaceae (3 species) families are the most commonly used. In fact, the frequent use of Lamiaceae is due to its richness in bioactive compounds, its widespread traditional use and its culinary and cultural uses [29].

59.3% use cultivated plants, reflecting local preferences, as noted by [30]. Dried plants dominate (45.2%), supporting findings that drying preserves active ingredients [31]. Leaves are the most utilized part (32.3%), due to ease of collection and high bioactive compound levels [32].

The study population primarily uses decoction for medicinal plants, who states that this preference is due to compromised renal function in hemodialysis patients, necessitating caution with therapeutic plants. Decoction enables controlled extraction of active ingredients, minimizing harmful compounds for failing kidneys. In this term [33], states that boiling provides an efficient method for extracting active compounds from plant parts, while allowing greater control of the extraction processes that minimizes unwanted compounds. This control is particularly important in the case of kidney pathologies. Given that some plants can pose toxic risks. In this context, Excessive consumption of *Allium sativum*, plant used by our studied population, can cause gastric irritation, skin or respiratory allergies and an increased risk of bleeding in people taking anticoagulants. Toxicological studies on garlic show good general tolerance at usual doses but adverse effects appear in cases of overdose [34]. Moreover, extracts of *Acacia senegal* leaves contain polyphenols, flavonoids and tannins, which may modulate bacterial activity, although little acute toxicity has been reported. A study shows biological activity without significant toxic effects at moderate doses [35]. Concerning *Artemisia absinthium*, its active ingredient is neurotoxic at high doses, which explains the risk of seizures and other neurological disorders. An experimental evaluation of the essential oil confirmed these toxic effects at certain concentrations of *Artemisia absinthium* [36]. *Moringa oleifera*, it is generally well tolerated but it can nevertheless be toxic at very high doses, at least affecting liver and kidney function absinthium [37].

In this term, states that boiling provides an efficient method for extracting active compounds from plant parts, while allowing greater control of the extraction processes that minimizes unwanted compounds [38]. This control is particularly important in the case of kidney pathologies. Given that some plants can pose toxic risks.

Additionally, the local population favors decoction for warming the body and disinfecting plants [39].

We found a significant correlation between socio-economic and type of medicine preferred, older patients are consistently those with a stronger preference for traditional medicine. This aligns with the results supporting that the preference for traditional medicine among elderly patients corresponds to the weight of persistent culture in pre-modernization health cohorts, financial pressure that hinders access to biomedicines and therapeutic fidelity to historically rooted traditional treatments [40].

The level of education was also significantly correlated to the use of combined medicine confirming its decisive role among the factors socioeconomic health factors. This finding is consistent with WHO [41] who note that patients with a higher level of education are more likely to choose both types of medicine (traditional and modern).

However, a moderate positive correlation between monthly income and the type of medicine was observed which proves that patients having moderate incomes more often opt for a hybrid medical approach (traditional and modern), whereas the majority of the poor population (<2,500 DH/month) favors herbal medicine.

We found a positive correlation between social coverage and medicine type, indicating that institutional social protection beneficiaries are likelier to use traditional medicine alongside modern care. This supports Chen *et al.* [42] who noted that unprotected individuals use traditional medicine exclusively 3.2 times more than those with protection due to barriers to conventional care. Financial exclusion and medical desertification in rural areas contribute to a two-tier healthcare system, where traditional medicine serves as a safety net for vulnerable populations [43].

Thus, this study highlights the need to encourage clinicians to regularly inquire about the use of MP by patients, while integrating this use into public health policies through strict and rigorous regulation of these plants.

CONCLUSIONS

Medicinal plant use is common among older, low-income hemodialysis patients in northern Morocco. This practice is influenced by socio-economic and cultural factors, with a great diversity of species used, mainly in the form of decoction. While it reflects cultural heritage, it poses significant risks such as nephrotoxicity, drug interactions and risk of specific adverse effects. Therefore, phytovigilance is essential to ensure safe use and raise awareness of potential side effects among the public and health professionals. In this context, one of the recommendations is the need to establish a national system for the active monitoring of adverse plant effects, including a centralized database accessible to

healthcare professionals and researchers. Targeted patient information campaigns, continuing education for practitioners on known risks and the regulatory integration of plant protection products into existing pharmacovigilance systems appear essential. Likewise, further future studies are needed to provide a specific ethnobotanical depth to the Moroccan region, particularly by contextualizing uses within a specific social, cultural and therapeutic framework, an establishment of standardized ethnobotanical evaluation protocols and a development of education strategies.

Limitations

This study has a number of important limitations: first, it is solely based on hemodialysis patients enrolled from a single area in northern Morocco, making it impossible to generalize the study findings to different geographical locations or population groups. Second, the data collection is based on administered questionnaires, which may lead to response bias for patients with a low level of education. In addition, the study period remains limited in time, not allowing for the consideration of seasonal variations or long-term changes in practices.

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Conflicts of Interest

No conflict of interest was declared by the authors.

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